

UNCLASSIFIED

AD 401 570

DEFENSE DOCUMENTATION CENTER

FOR

SCIENTIFIC AND TECHNICAL INFORMATION

CAMERON STATION, ALEXANDRIA, VIRGINIA



UNCLASSIFIED

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

401 570

(5) 17511

STEP
24.2/20
3.1560

11.93
S/033/62/039/005/006/011
E032/E514

AUTHOR: ⑧ Klimishin, I.A.

TITLE: ⑨ On the theory of stellar shockwaves

PERIODICAL: Astronomicheskiy zhurnal, v.39, №.5, 1962, 887-893

TEXT: Stellar shockwaves are usually investigated using the "classical" theory of shockwaves in a moving gas (L.D.Landau and Ye.M.Lifshits, Mekhanika sploshnykh sred (Mechanics of Continuous Media), GITTL, Moscow, 1953). This theory predicts that the temperature behind a shockwave moving with a velocity of the order of 1000 km/sec in a stellar envelope should be of the order of 2×10^7 deg, whereas observations indicate that the maximum temperature on the surface of a new star immediately after the explosion is of the order of $10^4 - 10^5$ deg. One suggestion to obviate this difficulty has been that the temperature is reduced as a result of the emission of radiation into the surrounding space. The present paper is concerned with another mechanism responsible for the reduction in the temperature. Thus, a stellar envelope consists of a gas-radiation mixture and the latter may often play an appreciable role. When a shockwave

Card 1/4

On the theory of stellar shockwaves S/033/62/039/005/006/011
E032/E514

passes through such a medium a part of the wave energy may be spent not only in increasing the internal energy of the gas but also in increasing the radiation density. Hence, for given shock-wave velocity, the temperature behind the wave front may be less than the temperature given by the "classical" theory. The present paper is concerned with the generalization of the "classical" theory and considers the thermodynamic equilibrium of a gas-radiation mixture. It is shown that the equation for the adiabatic curve for such a system is

$$\frac{7(\gamma_2 - 1) + \beta_2(8 - 6\gamma_2)}{\gamma_2 - 1} \cdot \frac{\beta_1}{\beta_2} \cdot \frac{T_2}{T_1} - \frac{7(\gamma_1 - 1) + \beta_1(8 - 6\gamma_1)}{\gamma_1 - 1} - \frac{1 - \beta_1}{1 - \beta_2} \left(\frac{T_2}{T_1} \right)^4 + \frac{\beta_1}{\beta_2} \frac{1 - \beta_2}{1 - \beta_1} \left(\frac{T_1}{T_2} \right)^3 = \frac{2\beta_1}{RT_1} - \frac{2\beta_1}{R_1 T_1 \rho_1 u_1} \quad (9)$$

where subscripts 1 and 2 represent the state of the gas before
Card 2/4

On the theory of stellar shockwaves S/033/62/039/005/006/011
E032/E514

and after the passage of the shockwave, γ is the adiabatic exponent for the gas, β is the ratio of the gas pressure to the total pressure, T is the temperature of the mixture, q is the amount of bound energy liberated in the wave front, F is the flux of radiation from the surface of the shockwave front and u is the velocity of the gas relative to the wave front. This result is then used to find the discontinuities in physical parameters across the shockwave front. The results obtained are very similar to those considered by K. P. Stanyukovich (Neustanovivshiyeva dvizheniya sploshnoy sredy ["Non-steady Motion of a Continuous Medium"], Gostekhizdat, 1955). It is shown that the ratio of the gas to total pressure behind the shock front decreases sharply with increasing temperature discontinuity at the wave front. When the amount of wave energy spent in increasing the radiation density is taken into account, it is found that the density discontinuity is increased and the temperature discontinuity is appreciably reduced. In particular, for a shockwave moving with a velocity of the order of 1000 km/sec in a solar-type stellar envelope, the temperature behind the

Card 3/4

On the theory of stellar shockwaves S/033/62/039/005/006/011
E032/E514

wave front is lower by a factor of 18.5 as compared to the temperature calculated from the "classical" shockwave theory. The general conclusion is that effects associated with the increase in the radiation density must not in general be ignored. There are 1 figure and 1 table.

ASSOCIATION: L'vovskaya astronomiceskaya observatoriya
(L'vov Astronomical Observatory).

SUBMITTED: June 27, 1961

Card 4/4